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(54) Washing machine

(57) A washing machine comprises a tank (10) for loading washing liquor and items to be washed and control means (22) adapted to carry out a predetermined washing program. The washing machine comprises a first electrode (4, 5, 6) electrically. insulated from the washing liquor and sensor means (2) connected to said first electrode (4, 5, 6) for detecting a value of a sensor formed by said first electrode and by the washing liquor acting as a second electrode, said value being fed to control means in order to control and/or adjust the washing program.

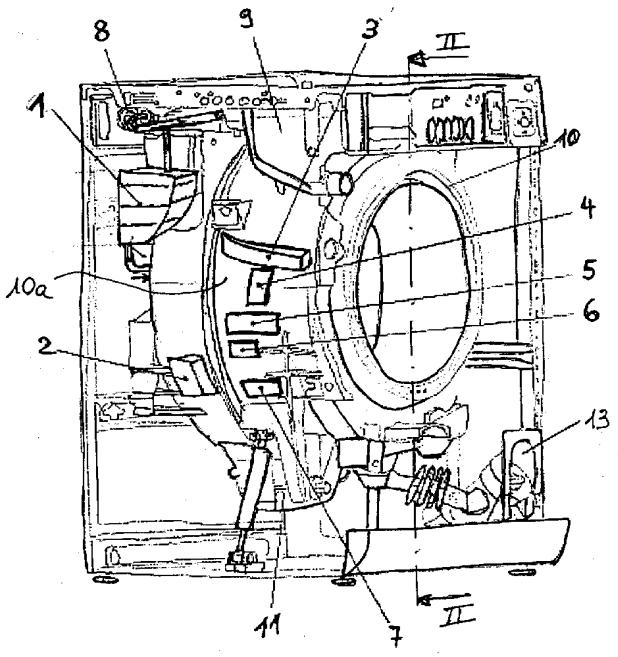

Fig. 1

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Description

[0001] The present invention relates to a washing appliance comprising a tank for loading washing liquor and items to be washed and control means adapted to carry out a predetermined washing program.

[0002] Washing appliances, for instance washing machines or dishwashers, carry out a program selected by the user on the basis of the amount and degree of soil df items. With the term "washing program" we mean hereby the entire program carried out by the appliance or a portion thereof. Usually, in the case of a laundry washing machine, the washing program comprises also the rinsing and spinning steps. Some washing appliances have sensors for detecting automatically the load and other parameters in order to self-adjust the washing program.

[0003] It is an object of the present invention to provide a washing appliance having a detection system able to assess the working condition thereof in a reliable and economical matter, and for assuring a self-adjustment of the washing process.

[0004] According to the present invention, the appliance comprises at least a first electrode electrically insulated from the washing liquor and sensor means connected to the control means and to the first electrode and adapted to detect a value of a sensor formed by said first electrode and by the washing liquor acting as a second electrode, said value being fed to the control means in order to control and/or adjust the washing program. The sensor means and the control means can be parts of a single electronic control unit. The value detected by the sensor is indicative of a capacitance and/or a complex impedance of the two electrodes.

[0005] In a preferred embodiment of the invention, the sensor essentially constitutes a capacitor. The first electrode is preferably a metal plate isolated from the washing liquor by a dielectric, for instance the insulating wall of the tank made of polymeric material. The second electrode of the capacitor is formed by the washing liquor (wash liquid in the tank or receptacle). The electrical connection between the detection means and the washing liquor is made through a metal body, for instance through the heating element body. The first electrode is spatially arranged so that wetting with washing liquor of the respective dielectric can occur. Preferably the first electrode is above the liquid level of the washing liquor as the temporarily applied liquid film can run off there.

[0006] In the case of a plastic tub the dielectric can be the tub itself, and the first electrode surface may then be arranged at various locations on the exterior of the tub or inserted in various locations into the tub wall respectively. The embodiment in which the first electrode is integral with the tub wall (for instance through a process of co-injection during the injection molding of the plastic tub) also provides a variety of functional benefits: simultaneous attachment of the electrodes prevents conductive contact of the electrode with potential impurities on the exterior of the tub (dirt buildup on the exterior of the tub, water condensation on the exterior of the tub, it reduces the distance between the metal or permanent electrode plate and the electrode sheet formed by the liquor film and subsequently increases the sensitivity of the electrode system).

[0007] The dielectric and the first (permanent) electrode can be arranged not only in the tub, but also in the drain tube or in an external chamber that is wetted by means of a specially controlled pump. The first electrode can be composed by several distinct electrodes geometrically arranged in the case of the plastic tub that electrically isolates and acts as a dielectric, or in a plastic tube (in which the washing liquor flows) on the exterior thereof and/or with electric insulation also within the tub or tube respectively. In the case of an electrically conductive tank, e.g. a stainless steel tank, the capacitive sensor may be realized completely within the tank or completely outside the tank respectively.

[0008] The spatial arrangement is always chosen thereby such that through controlled wetting of the dielectric with liquor (e.g. by drum movement, or by a special pump) the result is a ground electrode with a variable surface. The film, which is the result of controlled wetting, (variable plate capacitor in the area of the permanent electrode) then runs off in the gravitational field after controlled wetting on account of the spatial arrangement. In addition, wetting can be intentionally interrupted, for example, by means of the pump or the drum movement in order to record the runoff flow in terms of time. The variation in the signal from the capacitive sensor gives information on the detergent concentration, the degree of rinsing and other important parameters which may be used to control the washing program. Furthermore, wetting by means of the drum can also occur continuously, e.g. by means of the wash liquid entrained by the drum at a certain rotation speed and the runoff of the wash liquid on the receptacle wall, so that an equilibrium can be reached and a constant wash liquid level is achieved. The height of this level depends on the properties of the wash liquid. The resulting signal (capacity) is indicative of the mechanical properties of the boundary layer of the wash liquor on the sensor surface based on the runoff process on the sensor surface, and/or on an arbitrary surface, like fiber surfaces, for example, when washing and rinsing clothes. It is known that the mechanical properties of the boundary layer influence the washing process of fibers and/or arbitrary surfaces and the rinse process of fibers and/or arbitrary surfaces. Subsequently, it can be used in part to monitor wash and rinse processes and to actively control by means of an adjustment process. The progression of such processes can be made visible through a display in the user field area.

[0009] The sensitivity of the signal is set by the size of the sensor surface and/or its arrangement. Vertical arrangement of the first sensor is preferred for the signal during the washing process. A flatter arrangement is

better during rinsing, since with increased rinsing action the liquid and/or film runs off more easily. In order to have always the best arrangement in different steps of the appliance cycle, different permanent electrode surfaces can thus be compiled into one multifunctional sensor. According to such embodiment, the first electrode can be divided into individual segments of known geometric arrangement. Subsequently, an arbitrary characteristic diagram curve can be plotted through targeted arrangement of the individual condenser components.

[0010] If the individual electrode segments are wetted from bottom to top as it may happen in a tub of an horizontal axis washing machine, for example by means of drum movement, than one obtains a discreet step signal, the traits of which can clearly be assigned to "levels" and/or a wetted sensor surfaces, as the surfaces and/or the sensor data of the individual components are known. This makes automatic calibration possible with software, which can be repeated as desired when the characteristic signal is attained. The distribution of the electrodes into segments also allows the electrode segments to be mounted in other places, e.g. to record the liquid column upstream from the discharge pump in order to be able to control turning the pump on and off in order to prevent air sounds in the pump, for example.

[0011] The first electrode surface should be arranged such that the film running off on its dielectric is influenced the least possible by disturbances. A disturbance can be a film running off from the above, for example. Using a shaped deflector on the inside surface of the tub this undesired running off is avoided, since the deflector leads the liquid and/or liquid film from above past the relevant sensor surface.

[0012] Disturbances can also occur due to films from softeners or other additives. For the sake of prevention, the sensor surface is preferably rinsed with freshwater. This special rinsing can be integrated into the program sequence such that after the softening cycle and/or after introduction of any additives the relevant surface of the sensor can be rinsed with the aid of a special chamber that can be filled with fresh water and subsequently purifies the film caused by the softener and/or additives. The whole sensor rinsing process can be repeated for control surveys.

[0013] The same device is used to differentiate suds from the film present during the wash process. Suds keep flowing again independently after rinsing and therefore usually cause the same signal. A wash-active film caused by the wash liquor is removed and/or weakened during rinsing. The signal returns only after active wetting, i.e. as described in the example above by rotation of the receptacle. The program control can evaluate this information and if necessary already optimize the program with special suds routines during the wash process.

[0014] It is preferred to integrate a reference capacity in the sensor which enables extensive elimination of temperature effects (temperature coefficient of different substances), life span drift by changing the substance and influences of various detergents, soil and water.

[0015] A sensor used in a washing machine according to the invention is simple and robust (no moving parts, conductive and isolating surfaces with integrated electronics) and it produces a signal already during washing that correlates with many parameters important for the wash and/or rinse and spin cycle:

- Under and/or over-proportioning of wash substances
- Changes (consumption) of wash activity of the liquor
- Concentration balance when rinsing
- Rinse effect, rinse result
- Occurrence of foam / suds during the wash and rinse process
- End of rinse
- Reference level when water flows in
- Spray water when spinning

[0016] By already having these parameters during operation, further washing program optimization is made possible together with already known parameters, in particular:

- Automatic proportioning and/or re-proportioning of detergents
- Ancillary automatic wash time adjustment of wash time for extreme soiling
- Partially regulated and/or automatic rinse process (time, water amount, quantity, mechanical system)
- Improved online display of the wash, rinse and spin programs
- Suds monitoring with active program change
- Indication: Under/over-proportioned, suds
- Controlled centrifuge turns
- Pump motor control

[0017] The present invention is described in the following by way of example with reference to the accompanying drawings, in which:

- Figure 1 is a perspective view of a partially sectioned washing machine according to the invention, in which the outside of the tub is shown;
- Figure 2 is a perspective view of a section taken along line II-II of figure 1, in which the inside of the tub is shown;
- Figure 3 is a schematic circuit diagram of a washing machine of figures 1 and 2.

[0018] With reference to the drawings, a washing machine comprises a plastic tub 10 having an outside cylindrical surface 10a. In the plastic tub 10 there is provided a rotating drum (whose only the rear portion 20 is shown in figure 2) driven by a motor 11. The tub 10 is loaded with fresh water through valves 8 and through a

detergent bin 9. On the outside surface 10a of the tub 10 there are placed three measuring electrodes 4-6 and a reference electrode 7. These electrodes are connected to an electronic unit 2, such unit being linked to a control process unit 22 of the washing machine (figure 3). The electronic unit is also linked to a heating element 12 placed in the tub, which is used also as electrical conductor in the washing liquor.

[0019] On the inside surface of the tub, indicated with the reference 10b, a deflector 3 is placed which acts as a liquid film tear-off device. The function of the deflector 3, which has an axis inclined with reference to the axis of the tub, is to channel the liquid coming down from the upper portion surface of the tub away from the zone where electrodes 4,5 and 6 are placed, in order to avoid the already mentioned problem of disturbance.

[0020] For avoiding the other disturbance problem due to the use of softeners or additives, the tub 10 presents a fresh water inlet nozzle 8a (figure 2) fed by an external chamber 1 (figure 1). The nozzle 8a faces the sensor surface and continuously supplies a defined amount of water. When rinsing the sensor, it is crucial that the entire surface is rinsed. This is achieved in that more freshwater flows into the chamber 1 than flows off below via the nozzle 8a. Thus the chamber 1 fills with freshwater. Subsequently, increasing static pressure results and the water running off thus successively reaches the entire surface of the sensor. The freshwater is shut off when the chamber is full. The water flowing off again has increasingly less pressure and the stream gradually diminishes. The volume of the chamber 1 is designed such that in most cases it cleanses the sensor.

[0021] Even if in the above description reference was made to a measurement of capacitance, nevertheless expanded assessment of the capacitive sensor may include provisions for measuring its complex impedance, allowing further interpretations of the measurement signal. This allows an enhanced signal evaluation including vectorial evaluation of the impedance of the entire system subject to the frequency. It is to be expected that thin layers, films, liquid medium, powder and suds can be differentiated therewith.

[0022] According to the above features, a washing appliance according to the invention may assess many parameters of the wash program, as amount of detergent in wash and/or rinse water, soil amount in the wash water, wash activity of the wash water, rinse efficiency, suds and foams occurrence, and level of the wash water, these parameters being used for controlling and optimizing the wash program.

[0023] Moreover, the signal form the sensor can be used to monitor of the discharge pump too.

Claims

1. Washing appliance comprising a tank (10) for loading washing liquor and items to be washed and control means (22) adapted to carry out a predetermined washing program, **characterized in that** it comprises at least a first electrode (4, 5, 6) electrically insulated from the washing liquor and sensor means (2) connected to the control means (22) and to said first electrode (4, 5, 6) and adapted to detect a value of a sensor formed by said first electrode and by the washing liquor acting as a second electrode, said value being fed to the control means in order to control and/or adjust the washing program.

2. Washing appliance according to claim 1, **characterized in that** the value detected by the sensor is indicative of capacitance and/or complex impedance of said electrodes.

3. Washing appliance, particularly washing machine, according to claim 1, **characterized in that** the first electrode (4, 5, 6) is placed on the outside surface of the tank (10a, 10).

4. Washing appliance according to claim 2, in which the tank (10) is a cylinder having a substantially horizontal axis, **characterized in that** the first electrode (4, 5, 6) is placed on the cylindrical surface (10a) of the tank (10) in a intermediate position between the bottom and the upper portion of the tank (10).

5. Washing appliance according to claim 3, **characterized in that** the first electrode comprises a plurality of electrodes (4, 5, 6) placed in different positions on the tank (10, 10a).

6. Washing appliance according to any of the preceding claims, **characterized in that** the electrical connection between the sensor means (2) and the washing liquor is made through a heating element (12) or through an additional electrode placed in the tank (10).

7. Washing appliance according to claim 3, **characterized in that** on the internal cylindrical surface (10b) of the tank (10) a deflector (3) is placed for protecting a zone corresponding to the first electrode (4, 5, 6) from the washing liquor flowing from the upper portion of the tank (10).

8. Washing appliance according to any of the preceding claims, **characterized in that** it comprises a reference electrode (7) connected to the sensor means (2) and adapted to correct the value indicative of capacitance and/or complex impedance from external factors.

9. Washing appliance according to any of the preceding claims, **characterized in that** it comprises cleaning means for cleaning an inside zone of the

tank (10) corresponding to the first electrode (4, 5, 6).

10. Washing appliance according to claim 8, **characterized in that** said cleaning means comprise a water nozzle (8a) fed by a chamber (1) placed outside the tank (10).

11. Washing appliance according to any of the preceding claims, in which the tank (10) is made of polymeric material, **characterized in that** the first electrode (4, 5, 6) is co-injected in the wall of the tank (10).

12. Process for washing laundry items in a washing appliance according to anyone of the preceding claims, **characterized in that** the signal information provided by the sensor is used for assessing one or more parameters comprised in the group consisting of amount of detergent in wash and/or rinse water, soil amount in the wash water, wash activity of the wash water, rinse efficiency, suds and foams occurrence, and level of the wash water, these parameters being used for controlling and optimizing the wash program.

13. Process according to claim 12, **characterized in that** the information provided by the sensor is used to control the discharge pump motor.

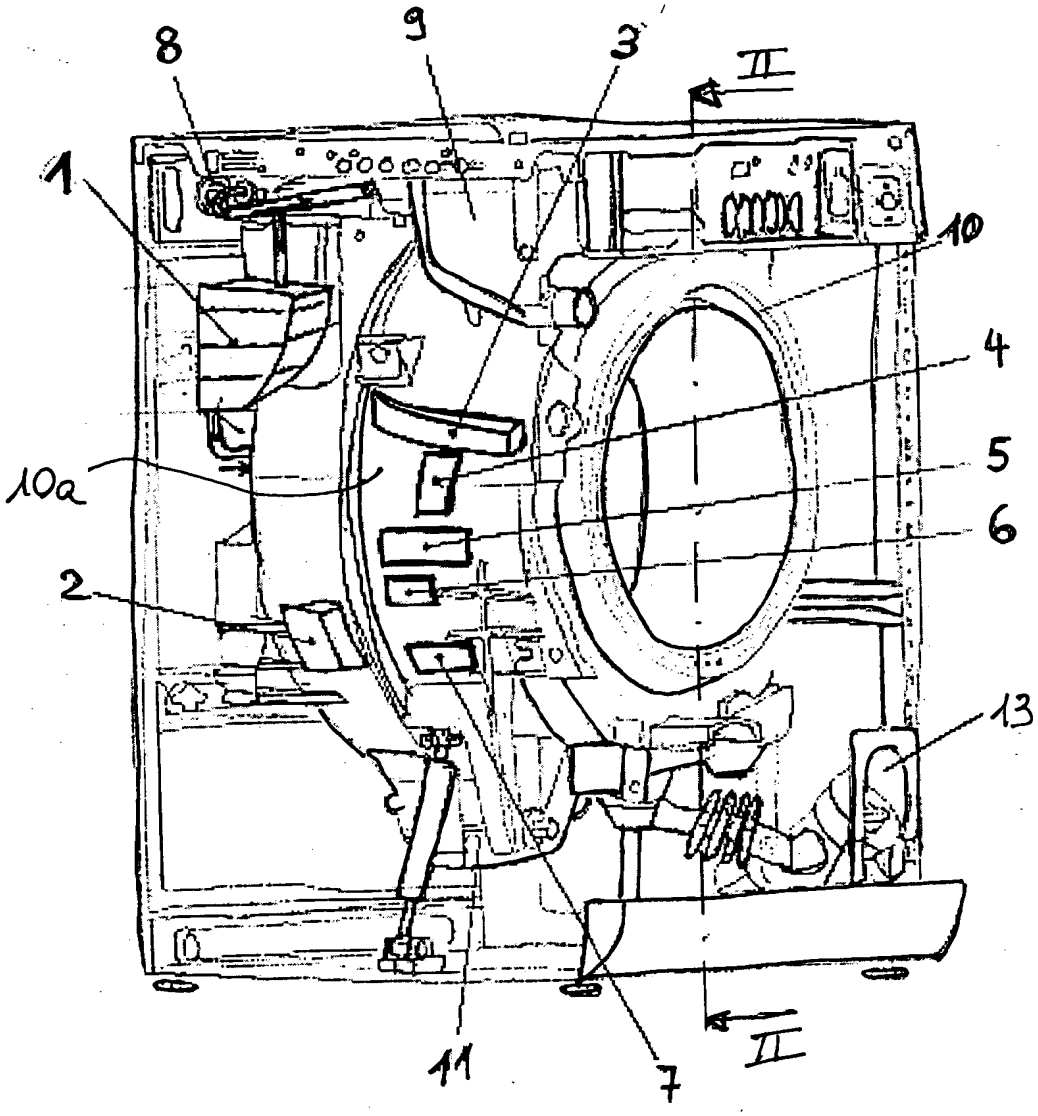

Fig. 1

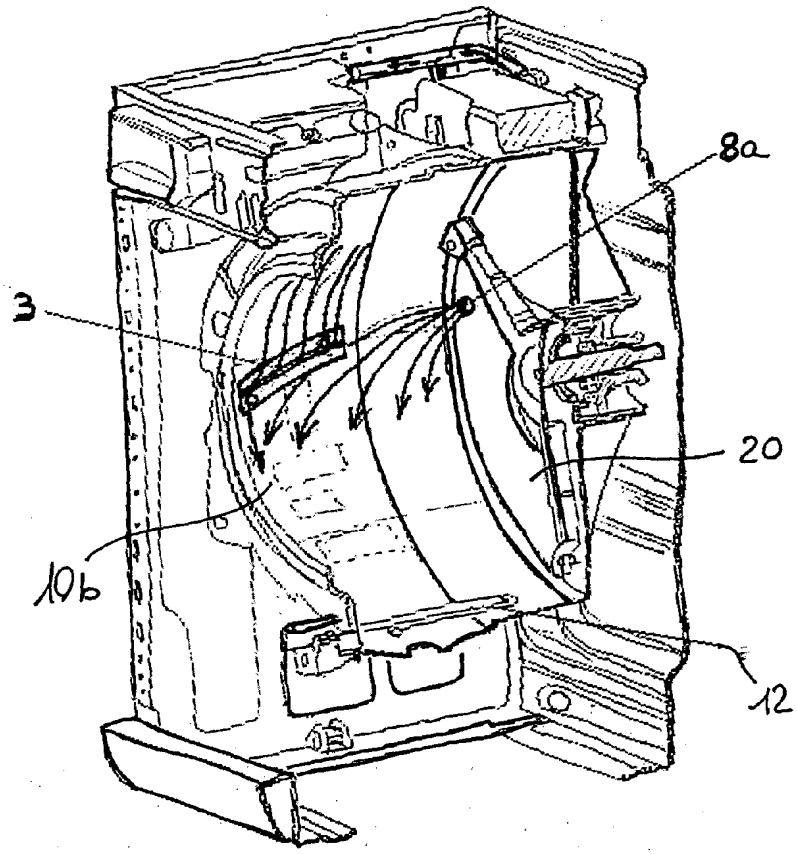

Fig. 2

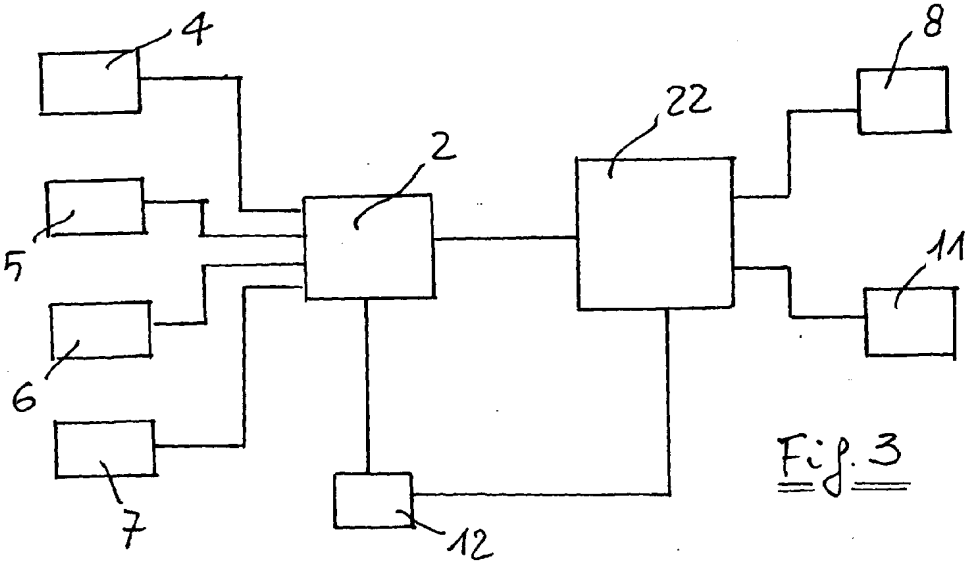

Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 00 1274

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	26 May 2003	Falkentoft, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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